A Ph.D. SYNOPSIS ON THE TOPIC

DESIGN AND DEVELOPMENT OF SAFE, INTELLIGENT MOVING MACHINE (SIMM) USING SOFT COMPUTING TECHNIQUES

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1. INTRODUCTION

The Intelligent moving machine which may avoid the obstacle, move intelligently and reach to the destination safely, accurately in minimum time and minimum cost. Earlier many moving machines were developed using different techniques for a real time path finder system. Man-Intelligent moving machine has become an important topic in the robots community. An advanced intelligent moving machine must integrate capabilities to detect human's presence in their vicinity and interpret their motion for an active interaction; the machine must also be able to track the static and dynamic obstacle in its path. The humans and moving machines coexist, closely interact and perform a certain amount of work. This research work is divided into two parts. The first part deals with the development of Safe Intelligent Moving Machine (SIMM), which maintains a certain relative positional relationship between the human and moving machine. The moving machine can carry loads that are required by people working in hospitals, airports, and industries etc. These machines are considered as an intelligent moving machine because they are able to interact with its environment and learn from the surroundings automatically. Interacting with nature and indoor situation involves learning and adaptation from changing environment. The intelligent machine can work as an assistant for humans in various situations. The second part of work related to the intelligent moving machine is obstacle avoidance in real time situation. The real time obstacle avoidance system of intelligent moving machine will be developed with help of soft computing techniques.

1.1 MOTIVATION

How does a person move in unknown areas and unknown paths?

Human Intelligence, Intuitiveness, capability of adaptation and the way obstacle avoidance in real time dynamic environment inspired the researcher to develop an intelligent moving machine which is safe, intelligent and optimally find its path in the static and dynamic, real time environment.

2. LITERATURE REVIEW

2.1 History of Moving Machines

Early work leading to today's industrial machines can be traced to the period immediately followed by World War - II. During the late 1940's research programs were started at the Oak Ridge and Argonne National Laboratories to develop remote mechanical manipulators. These systems were of the "master-slave" type and designed to reproduce faithfully motions made by a human operator. The master manipulator was guided by the user through a sequence of motions, while the slave manipulator duplicated the master unit as closely as possible. In the mid – 1950's the mechanical coupling was replaced by electric and hydraulic power in manipulators such as General Electric's (GE) Handyman [GAV 99].

While programmed moving machine offered a novel and powerful manufacturing tool. It became evident in the 1960's that the flexibility of these machines could be enhanced. The researchers at the Stanford University developed computer with hands, eyes and ears, manipulators, T.V. Cameras, and microphones. The system recognizes and manipulates in accordance with instructions [MAT 07]. In 1974, Cincinnati Milacron introduced its first computer-controlled industrial moving machine. "The Tomorrow Too", it could lift as well as track moving objects, since then various control methods have been proposed for serving manipulators. In general, it is the fact that "intelligence" is capable for learning and adopts from the environment. When we talk about intelligent machines, the first thing that comes in our mind is robots. In fact, robots have been developed as the substitute of human and perform lot of task in daily indoor environment repetitively. However, robots are operated based on algorithm and fully controlled environment are not consider as a intelligent moving machines. Such robot easily fails when the application contains some unexpected or uncertain situation and if proper safety codes are not followed then it is very risky. Now in early day's Google autonomous vehicle has been designed for completing many tasks in daily life. These vehicles known as "Smart Google Car" which driverless and take all action by self intelligence. In 2010, Smart Google car technology is innovative and all performing action is based on real time situation. The smart car has been designed fully automated and used various types of sensor. The most common problem in motions are of the vehicle and whatever it is carrying load should not collide with the obstacles or objects in the

environment. In brief review there are several obstacle avoidance algorithms have been developed in different domains. The hypothesis and test method was the earliest proposal for real time obstacle avoidance. The main advantage of the hypothesis and test is its simplicity and easy formation. The second class of algorithm for obstacle avoidance is based on defining a penalty function on manipulator configurations. In penalty configuration collisions and drops off sharply with distance from the objects. An approach proposed by Khatib [KHA 86] is intermediate between these two extremes. The approach uses penalty function which satisfies the definition of potential field at a point on the vehicle is interpreted as repelling force acting on that point. The third approach of obstacle avoidance is explicit representations of subsets of moving machine configurations that are free of collisions, free space. The disadvantage is that the computation of the free space is expensive and complex. Regenerative braking system refers to a process in which a portion of the kinetic energy of the vehicle is stored by a short term storage system. Energy is normally dissipated from the brakes is directed by the power transmission system. Research by Volkswagen has shown that a hybrid drive with both electric drive and potential fuel saving of over 20 percent compared with just 5-6 percent from purely electric. Unlikely, intelligent moving machines can perform task and can be more useful when operating in uncertain, unpredictable situations. These intelligent moving machines have learning capability to enhance and sharpen its own existing knowledge for similar situations improve its own performance.

3. APPLICATION OF MOVING MACHINES

3.1 Micro Aerial Vehicle (MAV)

There are some aerial target and missions that are not suitable for human pilots because of dangerous operations or it takes a long time to complete the task. Yet, these tasks are very important for our defence forces. MAVs have been invented to carry out such mission-tasks. A MAV comprises onboard processing abilities, vision, global positioning navigation and wireless communication. One of the main advantage of MAV is to navigate in an uncertain environment, which is known as undefined or risky environment and/or to perform the require task at the same time [RZH 04]. As it is not possible to navigate, the MAV has to learn from its outdoor environment, and adapt the changes as they require to complete the task and to reach the destination. The MAV

used to collect the information from the atmosphere between satellite communication and ground base station. The MAV is able to observe the portion of planet that never seen before [WAT 07]. The MAV is designed with special cameras and multi sensors, and is able to monitor the situations. It has the capabilities of real-time processing the weather information.

3.2 Underwater Robot

The underwater invention has attracted the attention of researchers and engineers for ages, as they are many parts of the sea that are unknown to human beings. Another purpose for exploring the oceans is because of interests, communication, oil pipe lines, and gas lines are placed under sea water. This research in intelligent machines gave new dimensions that are capable for inspection of line and they can maintain the fault under water. Today, remotely operated water robots have been used to control and maintain the underwater operations safe An underwater robot is to inspect and capable to repair a fault in pipelines [SCH 00]. The robot is controlled from the instructions of fuzzy rule based expert system and it has a quality to complete the task in uncertainty and hazy environment.

3.3 Space Vehicle

One of the best applications of moving machines is space robots. In this research one of the opportunity is latest Mars rovers which sent by many space agencies like NASA and ISRO. Its main target is to take pictures of Mars, and send them to Earth [SAT 10].

3.4 Humanoid Moving Machine

Humanoid machine are designed to work like humans. It contains movement, intelligence and activities like a human. This intelligent machine can sense, actuate, plan, control and can move. Each of these intelligent moving machines has its features. ASIMO is fast moving robot. So this machine can walk and also able to detect the obstacle in its path. This intelligent moving machine is able to control its motions and can do conversation with the humans by its own intelligent like face expressions, movements of lips, and behaviour [SCH 99].

3.5 Other Moving Machines

Unmanned Combat Air Vehicle (MAV) [PJT 06] the main objective of this work is to provide sharp strike on the target by missile and emerging age of intelligent machine in science and technology.

Similarly, Micro-mechanical Flying Insect (MFI) is an insect like machine which capable to fly autonomously in the outdoor environment. Medical Micro robot (MMR) is very useful project in medical department and the size of this robot is very micro and it used to transmit images and deliver the payload.

After the discussion of various applications of moving machine in different sectors, the next section deals with different techniques to make the moving machine intelligent.

4.0 APPROACHES TO MAKE MOVING MACHINE INTELLIGENT

4.1 Neural-Based Approach

The development of intelligent machines that are able to assist humans or performing independent tasks is one of the popular research areas [HOR 81]. In 1981, it has been shown that by implementing a variety of time-saving strategies, detection can be achieved using a sequential support machine, this is an interesting and powerful pattern classification method usable in intelligent machine. Also, a rigorous comparison with other gesture detector approaches in terms of speed and accuracy was conducted [JON 99]. Dynamics motion deals with mathematical modelling and formulation of equations for vehicle motion. Such equations are useful for simulation of dynamic equations of motion in the outdoor environment. The design of control equations for static and dynamic obstacle observation in moving machines are important [ROM 01]. Networks of sensors have been used for detecting and avoiding obstacles while machine is moving. The moving machine design is based on the map of its environment to explore objects such as path obstacles and the strategy is made to avoid them. For an autonomous mobile machine the difficulty is compounded in the person detection task because the motion of the target is heavily masked by the background motion generated by the machine movement [PJT02]. This approach uses image moving measurement so that it does not suffer from feature avoiding methods. The system is different from most real time obstacle avoidance systems. Conventional intelligent approaches to reduce the amount of processing and then applied to develop the intelligent moving machines.

4.2 Distributed Sensor Network Approach

The distributed sensor network based machines are simple in structure and handle a lot of data [MRH 93]. These type of moving machine uses many intelligent sensors to cope up with

the situations [GAV 99]. It has been reported that the approach of a human and a moving machine leads to interactions. The intelligent moving machines which are always find static and dynamic obstacle while moving in forward and backward directions [BTM 01]. In this work an intelligent environment is used in order to solve the problems. A moving machine uses multiple intelligent sensors, which are distributed in the outdoor environment. The distributed sensors recognize the obstacles and the moving machine is controlled from control commands [MOF 01]. It is one of the applicants located in one level higher than the mobile machine position estimation module. After a brief review, the aim is to develop a intelligent moving machine provided with simple and robust relative location technologies that do not require structuring the environment. They may have simple semi-reactive strategies that do not require the use of internal maps and the ability to find the smooth path [LHY 01]. This approach in based on a control system able to display and integrate an exploration, obstacle avoidance, target following behaviour and a relative location device based on an single emitter and a directional sensor system. The proposed method utilizes the error between the observed and estimated image co-ordinates to localize the moving machine controls. The Kalman filtering scheme is used to estimate the location of moving machine [PBK 01]. The proposed approach is applied for a moving machine in Intelligent (I) space to show the reduction of uncertainty in determining of the location of the machine. Its performance is verified by computer simulation [KAL 60]. In this approach the images of an obstacle are used as an absolute position estimation method for a obstacle avoidance machine in the I-space was presented. The Kalman filtering technique was adopted for experimental estimation. Next, the positions of the obstacle and the moving intelligent machine in I-space were measured by DINDs. It was observed that position estimation accuracy depends on the path of the walking human. Intelligent machine have to be able to detect and track the obstacles in a fast and reliable way. Many researchers present a solution for the avoiding obstacle problem that integrates hand and face detection, which are obtained respectively from the laser and the camera of a moving machine. The performance of three different techniques i.e. Extended Kalman Filter (EKF), Unscented Kalman Filter (UKF) and sampling Importance re-sampling particle filter [MOR 03]. While analyzing accuracy and robustness of moving machine in the hurdle path, obstacle tracking and avoiding system, UKF not only performs better than the EKF, but also require less hardware resources and better computational efficiency.

4.3 Vision- based Approach

In the development of industrial moving machine there is a target criterion as the ability to recognize individuals using vision [SKC 99], and to understand the situations in order to provide various real-life services. Real time obstacle avoidance machine developed until now use uses various types of cameras for detecting a target and some of them use other sensors [ARS 00]. This newly developed moving machine adopts a stereo vision system, and additionally a Laser Range Finder (LRF) is mounted on the vehicle to enhance the performance or avoidance in motion. The moving machine has to get the information of the target recognize it by some methods and continue following and track the obstacle in its path it quickly start avoiding it. The system uses accurate measurements by operating in combination with LRF [ZHO 01]. This system has a feature to change the fusion rate of vision and LRF data according to the congestion level of the movement space, and improve its performance [CTD 05]. The knowledge of static and dynamic obstacles in path is used in accomplishing a desired path finding technique. In this fusion technique the fusion rate depend on congestion information [KSH 06]. An advanced application using sensors independently are subject to an unavoidable limit. So, a system design integrating information from two or more types of sensor is required. Because the vision data containing abundant information plays a key role in the complex system, further development of the vision system is desirable [YNS 06].

4.4 Silhouette Extraction Approach

In a study [GAV 99] a new integrated computer vision system designed to detect multiple ambiguities and extract their silhouette with a pan-tilt stereo, camera, so that it can assist in avoiding and recognition in the field of Human-moving machine Interaction [LIN 01]. The proposed system was evaluated with respect to ground truth table data, and it was shown to detect and tracking the obstacle in its path. People and object can track very well and also produce high-quality silhouette [WTN 03]. Recently, machine systems for industries, personal services, and professional services have been developed by many researchers. The functions of moving machine sensors are divided into categories internal and external state. Internal state sensor is used for obstacle detection which used to design a machine and external sensors for range variables. In obstacle avoidance distribution the scene are different enough to be separated, for the tracking and obstacle avoidance methods [EAT 05]. This will take us from the noise and finally to catch the primitive edge of intensity discontinuity. The

low level components are not easily recognized, so that we are focusing on this stage or very minor obstacles in the path. This system is based on multi-sensor based detection and tracking system for real time moving machine. The proposed approach is based on practical and effective solution for real time movement of moving machine in populated environments [LCL 07]. A hybrid approach to obstacle tracking was adopted which is based on a new algorithm for path detection and it works well even in challenging situations.

4.5 Peer-to-Peer Communication Approach

Avoiding and tracking system is most useful in two respects [CRM 03]. First, it allows a target object to be tracked when laser-based face data ceases and the target walks behind a box [FKL 03]. Sensing machine are periods during which the tracker are periods during which the tracker updated the persons position using only the vision based estimate, hence the constant radius but changing angle, leading to an arc-like appearance. Secondly, the object tracking system allows a particular thing to track. The vision board initially locate the largest obstacle so that the overall system performs well. As a result it is capable of detecting and avoiding the obstacle in its path and manages it in a correct way. Fast obstacle detection for indoor moving machine, an obstacle detection algorithm was developed to address challenges including occlusions due to cluttered environments, changing backgrounds due to the moving machine motion, and limited on-board computational resources [KCJ 04]. Obstacle detection in autonomous indoor machines is very important and very challenging task. A depth image based system detection algorithm successfully detects obstacles under challenging conditions such as occlusion, clutter [MFW 08].

4.6 Optical flow and Kalman filter approach

Tracking and avoiding moving objects is one of the tedious tasks for motion analysis and understanding of moving machines [BEV 91]. The Kalman Filter (KF) has commonly been used for estimation and prediction of the target position in next stage. A number of approaches are used for prediction and detection of these obstacles which are based on the traditional Kalman filter [MOT 05]. High level vision processes to attempt various types of obstacles in the path uses optical flow algorithm which makes things easier. In the KF approach, it is presumed that the behaviour of a moving target could be characterized by a predefined model, and the models can be represented in terms of a state vector [MAT 07]. The moving machine is designed to track objects by spinning left and right to keep the object in sight and driving forward and backward to maintain a constant distance between the

machine and the object. Tracking with moving machine is an active research area and many successful systems have been developed, such as hospital assistance and pedestrian tracking and many industrial applications.

4.7 Integration of Curve Matching Framework and Heuristic Approaches

The Kalman filter has been improved for an intelligent moving agent to obstacle avoidance in real time situations [WOL 96]. In this approach KF combined with a curve matching framework using a heuristic weighted mean of two methods to enhance prediction accuracy of target tracking and catch the image of obstacle in static or dynamic environment [HZH 96]. In another work, the curve matched Kalman filter approach has been used for checking the repletion of characteristic motion patterns and how to track the obstacle and plan a path by its own intelligence [RCR 97]. The performance of the curve matching framework on real time obstacle avoidance system depends on efficient fusing of more number of sensor data.

4.8 Obstacle Avoidance with Kinect 3 D sensor Approach

In this tracking and obstacle avoiding approach a control system of human motion with Kinect on-board a machine is proposed. Kinect 3D sensor is sufficient to detect the obstacle in its path in real time walking with the velocity be less than one meter per second [BEY 02]. This work is related to the development and implementation of autonomous sensor based moving machine [RAM 03]. A wireless camera has been used for capturing the image and Matlab has been used to process the image, which was followed by controlling the machine to detecting the obstacle in its path. This system allowed the machine to differentiate a obstacle in a picture. The Distance Transform for shaped based detection on a moving vehicle was also used [MFW 08]. This approach has its own limitations such as when camera gets nearer to an object which create problems in comparing to existing models of the object. To overcome this problem a high speed vision and sensing system has been used. The moving machine with Kinect was able to track a obstacle successfully and at the same time processes all the data in microcontroller, and activate the motor control system [SAT 10]. This method is more accurate because it can detect obstacle in its path and also avoid the obstacle in its path. To track the obstacle in real world situation the reference point of the system are longer than the centre of circle technology [INM 14]. This technique will improve the ability of the kinect sensor to operate indoor and outdoor environment.

4.9 Wireless Communication

The main aim of this embedded application is to design a PC controlled moving machine which can detect and avoid the obstacle in its path and all these functions have been completed wirelessly [BMS 10]. The Zig Bee is used for efficient wireless communication. The Trans - receive system has longitudinal and latitudinal value when the system detects the obstacle in its range [AWA 14]. The proposed system uses a infrared sensor in order to detect the moving obstacles in real time. The circuit was assembled on PCB for better processing. The aim of this work is to make a moving machine which will detect and avoid obstacle in its path and plan a safe using wireless communication technology [PAT 11]. This approach is very useful in the disaster locations and tries to find a safe path to move out of that location. Special passive infrared sensors are used for detection or tracking.

4.10 Fuzzy logic Based Approach

Fuzzy logic based systems have been developed earlier for hurdle avoidance in walking machine. The Fuzzy Logic Controller for intelligent moving machine takes input from two ultrasonic sensors mounted in front of the machine and path finding and planning is done [BUR 01]. First, the system will recognize the situation and then start completing the task which will observe the condition of obstacle is that static or moving type. Then this approach start doing work in appropriate manner and gives information to the controller to make a map to move safely in that environment. The controller is designed using Fuzzy Logic Toolbox of MATLAB and its implemented with the hardware system [PDG 02]. The programming of a moving machine is an important task for designing a real time obstacle avoidance system which is described by machine motion. The machine is manipulated and control by the program code which is based on fuzzy logic where the obstacle may or may not be in the path. The sensor plays a vital role in designing of the real time obstacle avoider machine. The main task is to interface with sensors and to get the desired response at the output [SWZ 07].

4.11 LabVIEW and FPGA Integrated Approach

National instrument software architecture uses both low-level and high-level control. High-level tasks, such as obstacle avoidance and interpretation of sensor data, are executed on the embedded real-time processor; the obstacle avoidance algorithm uses the data from the IR and ultrasonic sensors to make decisions about how to capture its environment [BOR 88]. NI also has low-level control of the motors, which is implemented on the FPGA. Depending on the outcome of the obstacle avoidance algorithm, the data is transferred between the real-time

processor and the FPGA using FPGA interface functions built into LabVIEW. With LabVIEW Real-Time, LabVIEW FPGA, and NI single-board developers can rapidly design, develop, and deploy algorithms. The programming has been completed by LabVIEW because it is very popular and more sophisticated programming language.

4.12 Classical Motion Planner

Classical motion planners assume that the full knowledge of the geometry of the moving machine environment is known prior to move. In this the path is clear or also the type and location of obstacle known. A path is correct if it lies wholly within the free-space, and if the goal is reachable, connecting the initial position with the goal. Latombe [LAT 91], described a classical planner in some detail in his book, Machine Motion Planning, in which he splits the classical planner into three major categories: roadmap algorithms, cell decomposition methods and potential field approaches.

4.13 Cell Decomposition Approach

Although the concept of cell decomposition is quite simple, the implementation is more difficult. This group of algorithm split the space into parts; namely, obstacle space and free traversable space [NEL 97]. The exact variety of this group separates the space in trapezoids or polygons. The free space is constructed by combining all the separate free subspaces. In the approximate cell decomposition algorithms the space is discredited into small cell. If an obstacle is situated within a cell, the complete cell is disabled for traversal and thus the complete cell is added to the obstacle subspace. Just like the roadmap concept this group of algorithms constructs an obstacle free subspace wherein the moving machine is able to traverse without encountering an obstacle. Cell decomposition algorithms do not produce hard-to-follow one-dimensional curves but give safe corridors between obstacles. This property puts less pressure on tracking controllers but do not completely solve the path generation problem. As the moving machine depart from the starting point and the approaches to final destination which require the environment constraint such as moving in a crowded area where so many types of obstacles. The program must have control action and various approaches are used to reach to destination.

4.14 Heuristic Planning Approach

The class of heuristic planners, such as “Go To Waypoint” algorithm. This algorithm is based on the behaviour of moving machine [BOR 89]. The simplest version can be the following

control program the machine bases its trajectory on pre-programmed situations and criteria and execute pre-programmed commands. Although heuristic planners are designed to work well in most environment configurations, they lack completeness. There is no guarantee that the algorithm will halt, or that the moving machine will be able to find the goal even if a path exists [JBW 03]. The location and the dimension of the objects in the path can be identified to a certain degree. The sensory information acts as a feedback for moving machines to work. The current position of the intelligent machines is usually done by the encoders that measures and compute the position of obstacle in the workspace. Sensing is used in motion to provide the feedback for force as control action.

4.15 Embedded Based Approach

The use of embedded approach for complex environment is based on design and optimization of control system. In embedded system transforms information collected from the sensors and optimized it. The algorithm allows the cost functions to use a local search function which adopts a step size of machine [KCJ 04]. The control system is divided into multiple input and single output. The software implementation has been done by coding technique to control the system. This approach learns from the behaviour of the user. This technique is found successful for all static and dynamic type of obstacles. This approach can easily be implemented with tools and data available which may be conflicting [AWA 14].

4.16 A Dynamical System (DS) Based Approach

The obstacle avoidance in fast moving machine can adapt a target and obstacle position in dynamically motion environment [TOM 92]. Dynamical system is embedded into model considered the current position of the machine, the target, and all other working space. To model the moving machine with DS having situation where there is no time to plan, no matter how fast the planning to design and dynamically changes [PDJ 02]. The Dynamic environments contain both the static and dynamic challenge for obstacle avoidance. In early days the learning system introduce by map and map motion where avoiding real-time models. The derivation of dynamic system is simple and systematic; the resulting equations of motion, control devices, and gear friction are nonlinear differential equations. The dynamic equations can be applied to the link sequentially and follow the instruction forward and backward. The Incremental Hierarchical Discriminate Regression was used to find the results of obstacle avoidance moving machine [LTY 06].

TABLE -1 LITERATURE REVIEW OF SAFE, INTELLIGENT MOVING MACHINE

S. No	RESEARCH AREA	GOAL	REFERENCES
1.	Neural Based Approach	For obstacle detection and assisting of human	Horn (1981), Jones (1999) and Romdhani (2001)
2.	Distributed Sensor Network Approach	This intelligent machine design for avoiding obstacle which may be static or dynamic.	Haralick (1993), Gavrilla (1999), Granum (2001), Lang (2003) and Moreno (2003)
3.	Vision Based Approach	This moving machine design for industrial purpose.	Adam (2000), Zhou (2001), Treptow (2005), Hyams (2005) and Yoshimi (2006)
4.	Silhouette Extraction Approach	The machine design for industrial and as a human assisting agent.	Gavrilla (1999), Lindstrom (2001), Wang (2003), Topp (2005)
5.	Peer-to-Peer Communication Approach	Autonomous indoor machines are very important and design for indoor challenging task.	Coaniciu (2003), Fritsch (2003) and Marti (2008)
6.	Optical Flow and Kalman Filter	Motion analysis moving machine.	Borenstein (1991), Motai (2005) and Mataric Maja (2007)
7.	Integration of Curve Matching Framework	For real-time obstacle avoidance.	Wolfson (1990) and Rastogi (1997)
8.	Obstacle Avoidance with Kinect 3-D sensor Approach.	For detecting of human motion and control.	Beymer (2002), Ramanan (2003), Marti (2008) and Ilias (2014)
9.	Wireless Communication	Finding location and to used for as a path finder.	Sandeep (2010), Welch (2011) and Awad (2014)
10.	Fuzzy Logic Based Approach	Hurdle avoidance walking machine.	Burridge (2001) and Song (2014)
11.	LabVIEW and FPGA Approach	Industrial Application.	NI Systems
12.	Classical Motion Planner	Machine intelligence according to the environment.	Latombe (1991)
13.	Cell Decomposition Approach	Moving machine for hospital and airport used as a payload machine.	Nelson (1997) and Perez (2008)

14.	Heuristic Planning Approach	As a load machine for house application.	Koren (1991) and Jefferies (2003)
15.	Embedded Based Approach	Design for complex environment.	Kim (2004) and H.Hu (2006)
16.	Dynamical Based Approach	Obstacle avoidance and find a safe path for moving machine.	Tomasi (1992), Pratihar (2002) and Lee (2006)

Table – 2 Comparison of different Approaches for the development of Safe Intelligent Moving Machine

Techniques	**ANN**	**DSN**	**Kinect 3-D Sensor based**	**Wireless Communication Based**	**Fuzzy Logic Based**	**FPGA Based Approach**	**Cell Decomposition**	**Embedded Based**
Information Required	Quantitative data (Historical Data)	Distributed Sensor Info	Sensor Info	Binary info	Qualitative experience (Human Expert)	Binary info	Cell info	Info for Microcontroller
Development Time	Large training time	Sensor Deployment and integration time	Sensor Deployment and integration time	Integration time	Knowledge acquisition and representation time	Interfacing Time	Stop no function	Embedded system development time
Computational Burden	Large during training	Depends on number of sensors	Less Burden	large	Depends on size of rule base	less	Depends on Graph search algorithm	less
Speed	Fast	Medium	Fast	Medium	Medium	Fast	Medium	Very fast
Accuracy	Very Good	Depends on number of sensors	Good	Average	Average	Very Good	Good	Very Good
Tolerance with fuzzy/ill data	Good	Poor	Poor	Poor	Good	Poor	Average	Good

5.0 PROPOSED WORK

On the basis of historical evidences Microcontroller, embedded systems and appropriate Communication systems work to know engineering and understanding of obstacle detection and their avoidance. The state -of - art is both microcontroller and moving machine took advance steps in developing intelligent moving machine.

This work focuses on the design and development of safe intelligent moving machine (e-vehicle) which has the capability to avoid obstacle in real-time. These obstacles may be known or unknown, static or dynamic. Also the regenerative braking system concepts will be implemented on SIMM.

6.0 PROBLEM STATEMENT

In this work, a four wheeler e-vehicle will be developed which has intelligent obstacle avoidance system and regenerative braking system using soft computing techniques.

7.0 OBJECTIVES OF THESIS

The research work can be sub-divided into the following objectives:

1. To design and develop a safe intelligent obstacle avoidance system.
2. To design and development of an intelligent regeneration braking system.
3. Implementation in real time obstacle avoidance system on the four wheeler e-vehicle which is already working in university.

8. FUNCTIONAL BLOCK DIAGRAM OF SIMM

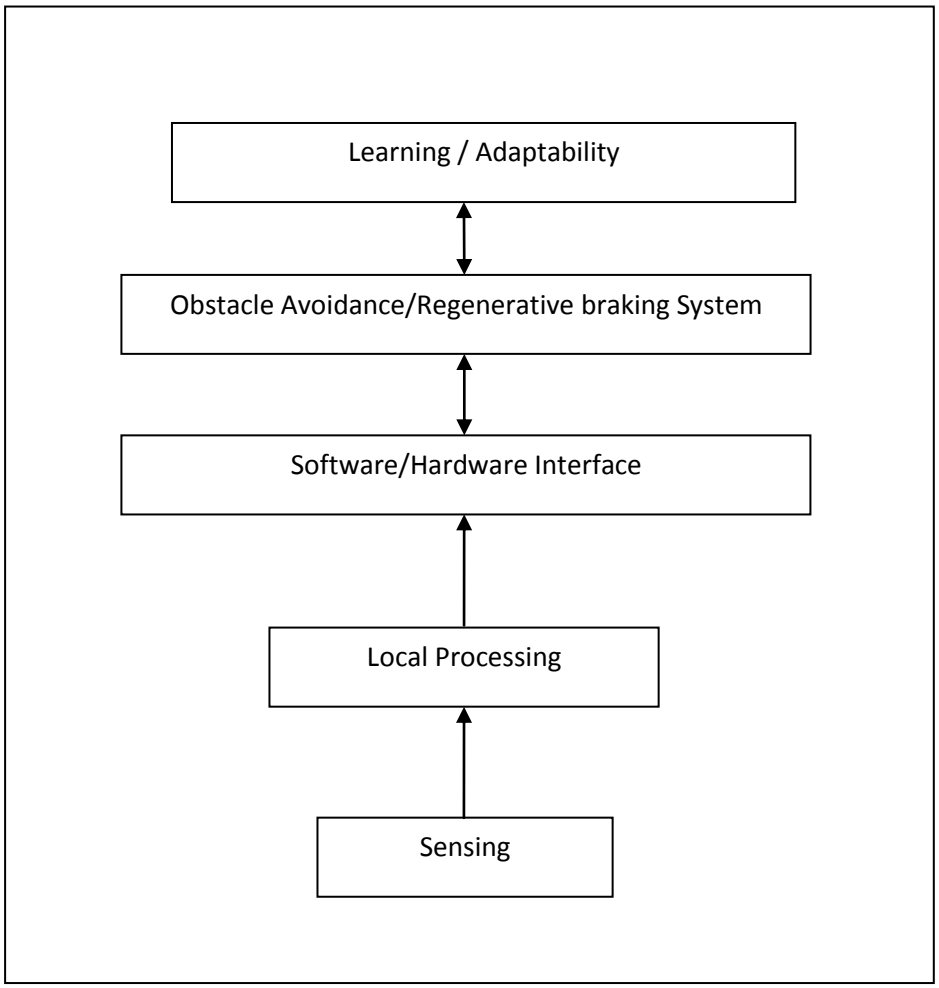

Fig. 1 Different Functional Block Diagram of SIMM

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